

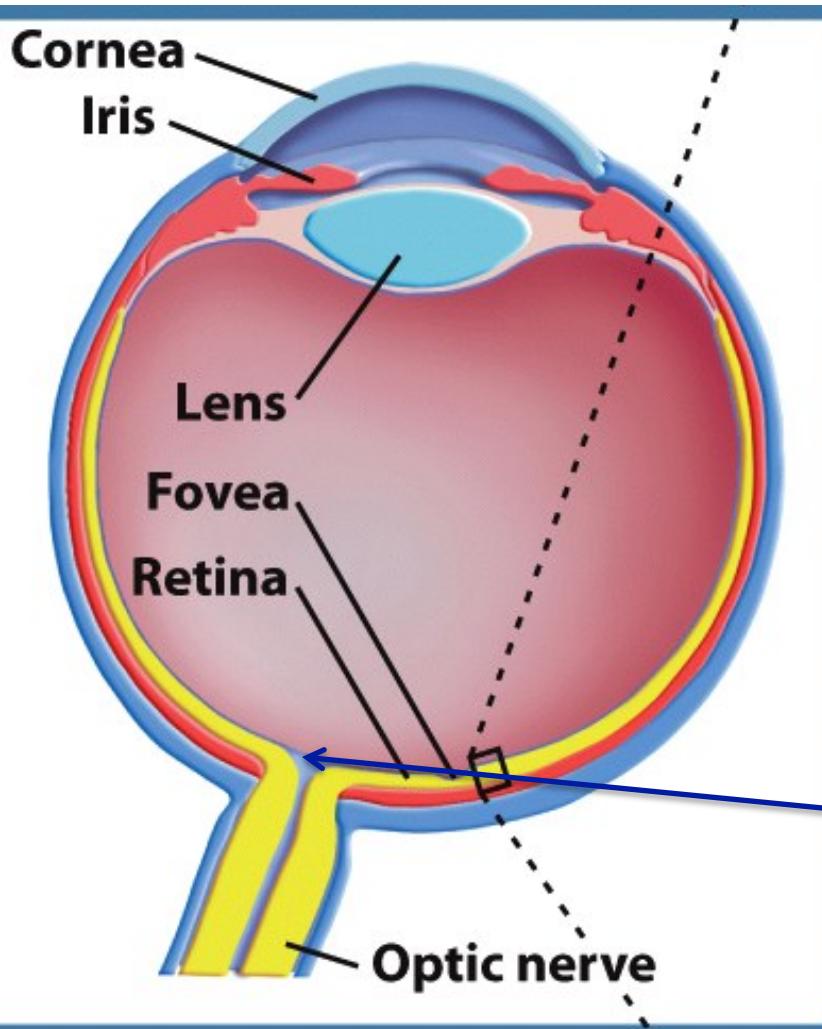
# PSYCHOLOGY 305

# COGNITIVE PROCESSES

## *Agenda*

- No Quiz
- Vision: Visual hierarchy
- Flexible mapping between external world and perception

# How is light converted into neural signal at retina?

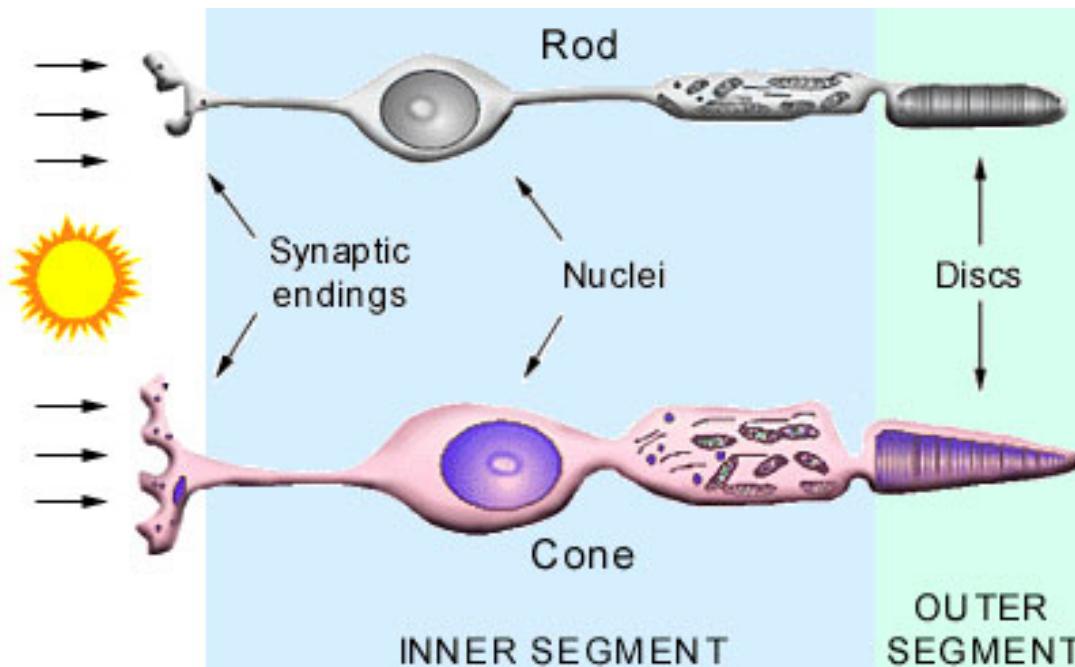


- Photoreceptors/retina located at the back of the eye.
  - pick up light and *transduce* light into signals
- information carried up optic nerve.

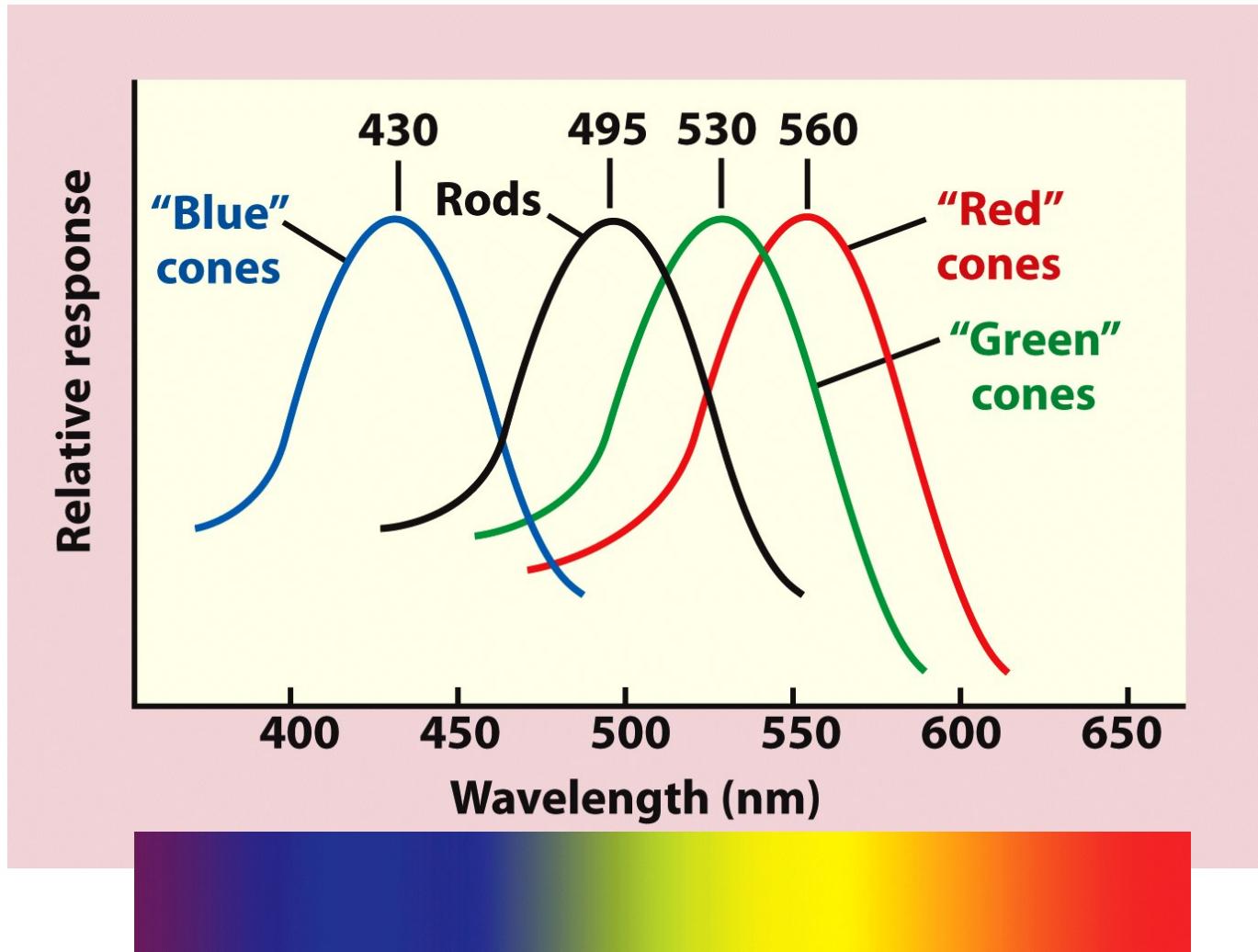
Blind spot

# Rods and cones

- Rods – black and white
  - Most sensitive
- Cones – color
  - Less sensitive

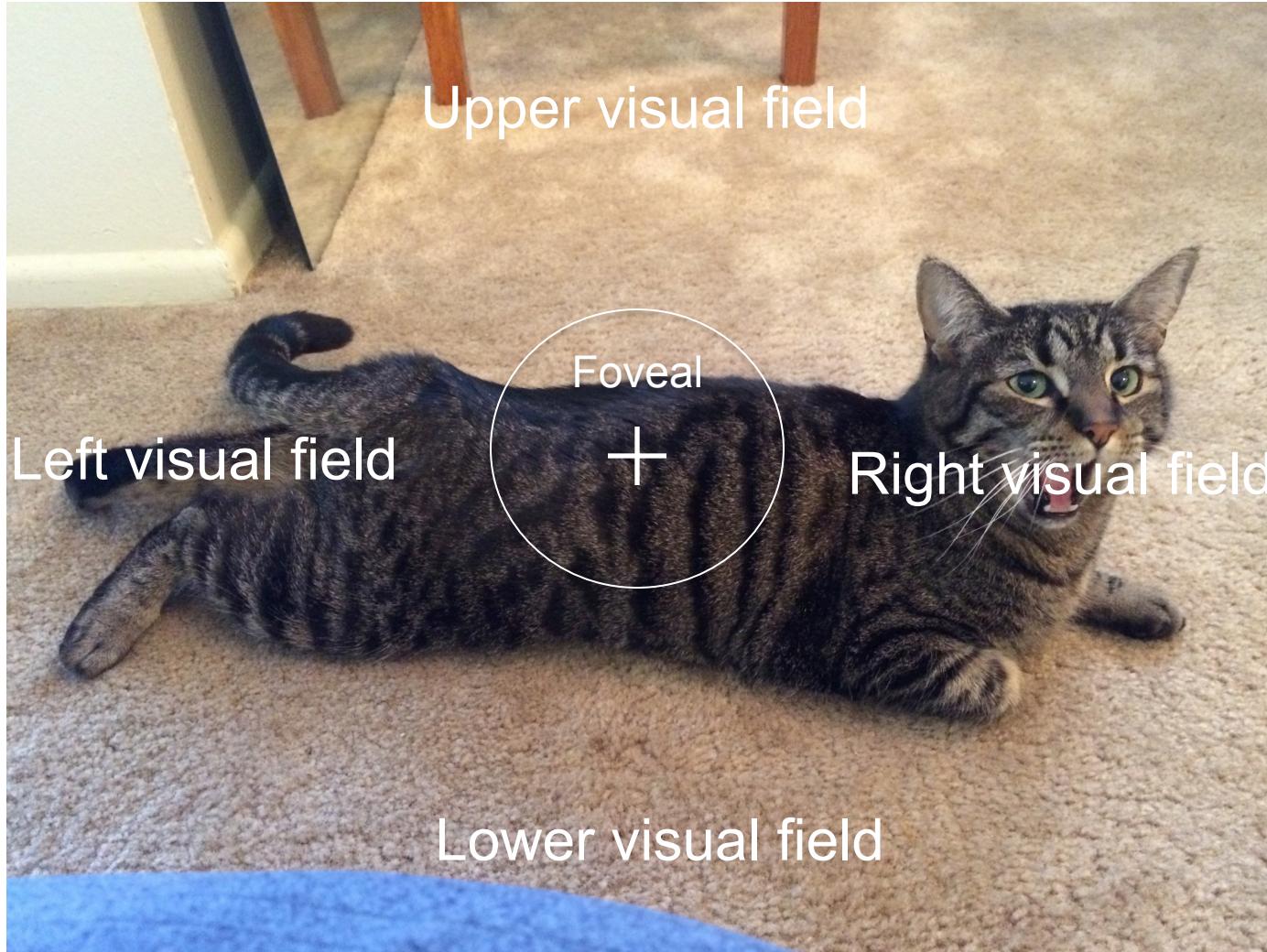


# Photoreceptors

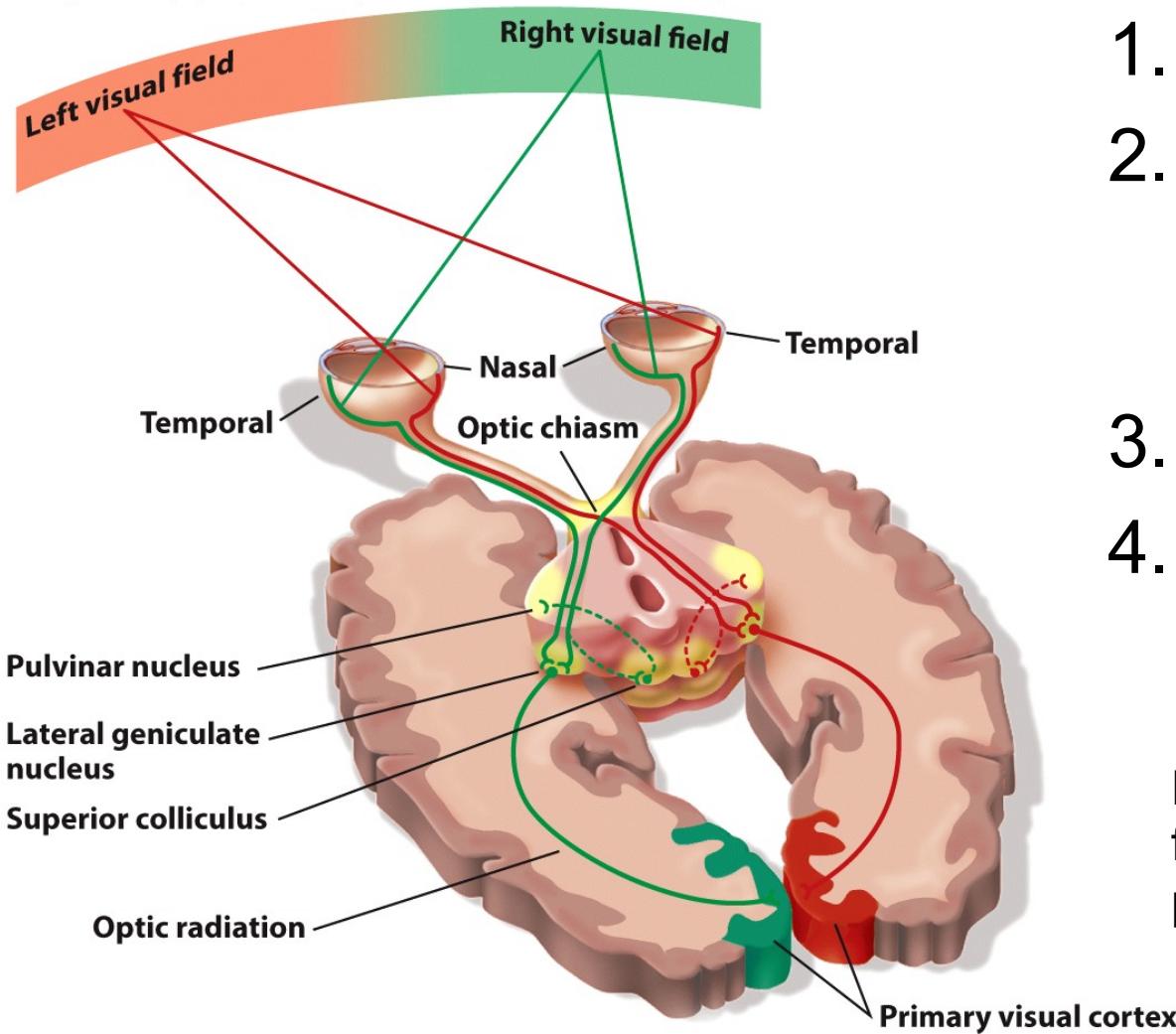


- Rods (sensitivity in dark) vs. cones (color sensitivity).
- Cones have optimal tuning to specific frequencies.

# Visual field



# Flow of information from optic nerve to V1

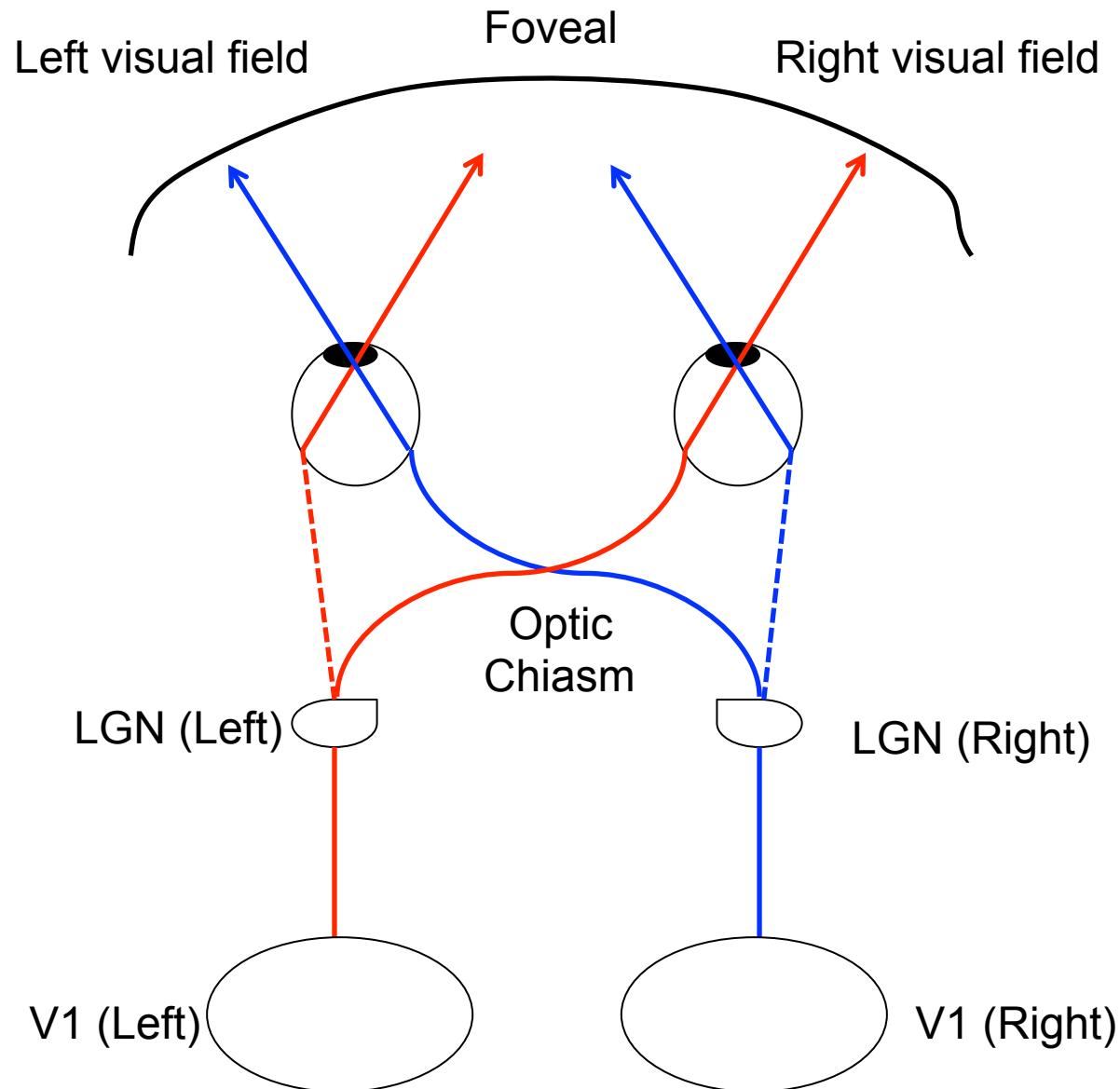


## Visual pathway

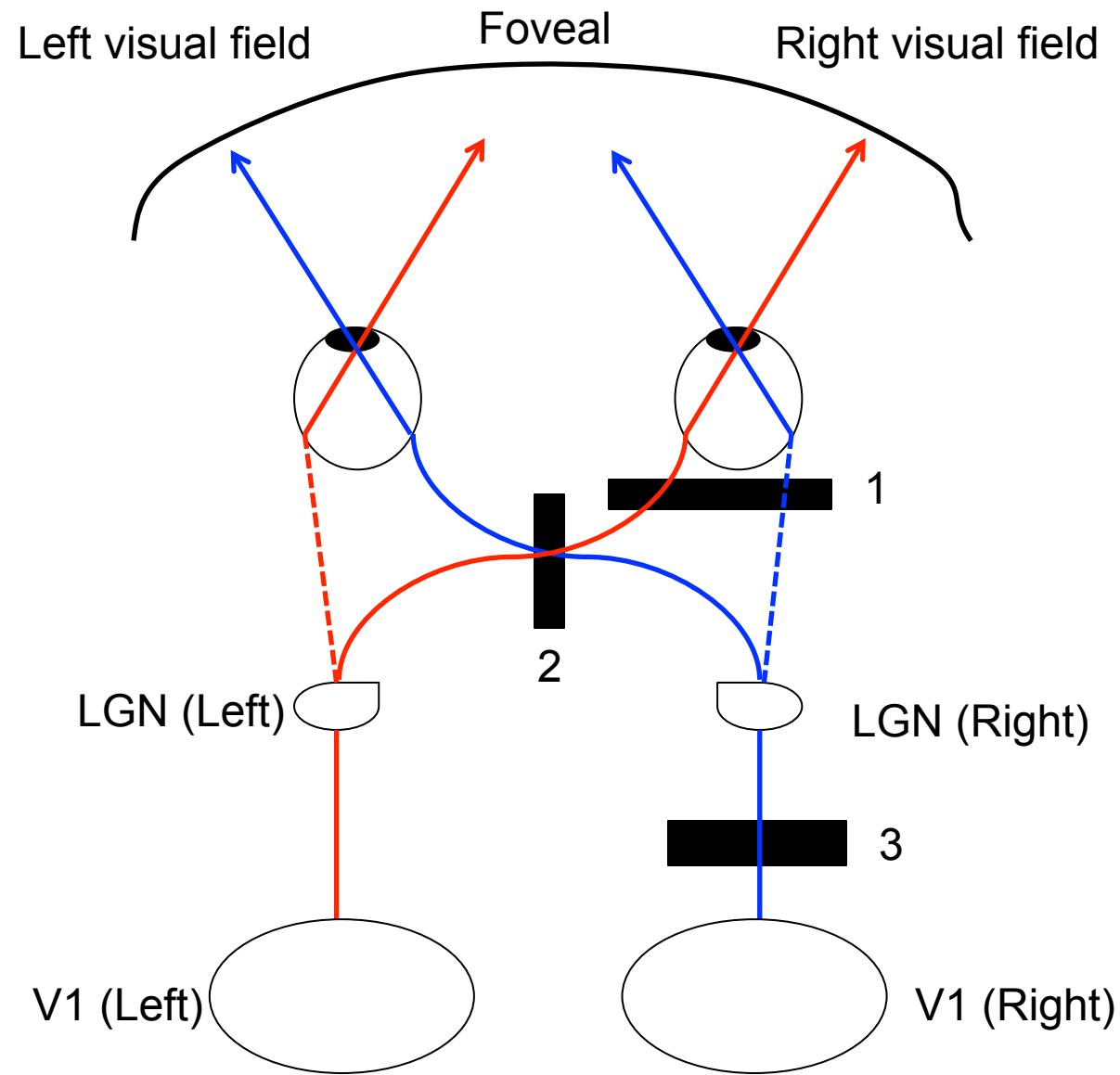
1. Light enters retina
2. Peripherals (nasal) cross at optic chiasm
3. Thalamus (LGN)
4. Visual cortex

Hemifield – the part of visual field that each hemisphere processes

# Visual pathway

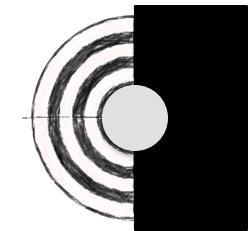


# Visual pathway lesions

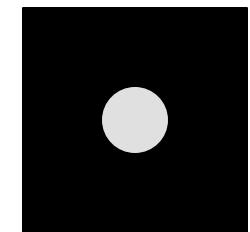


Visual field

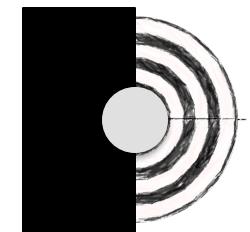
1



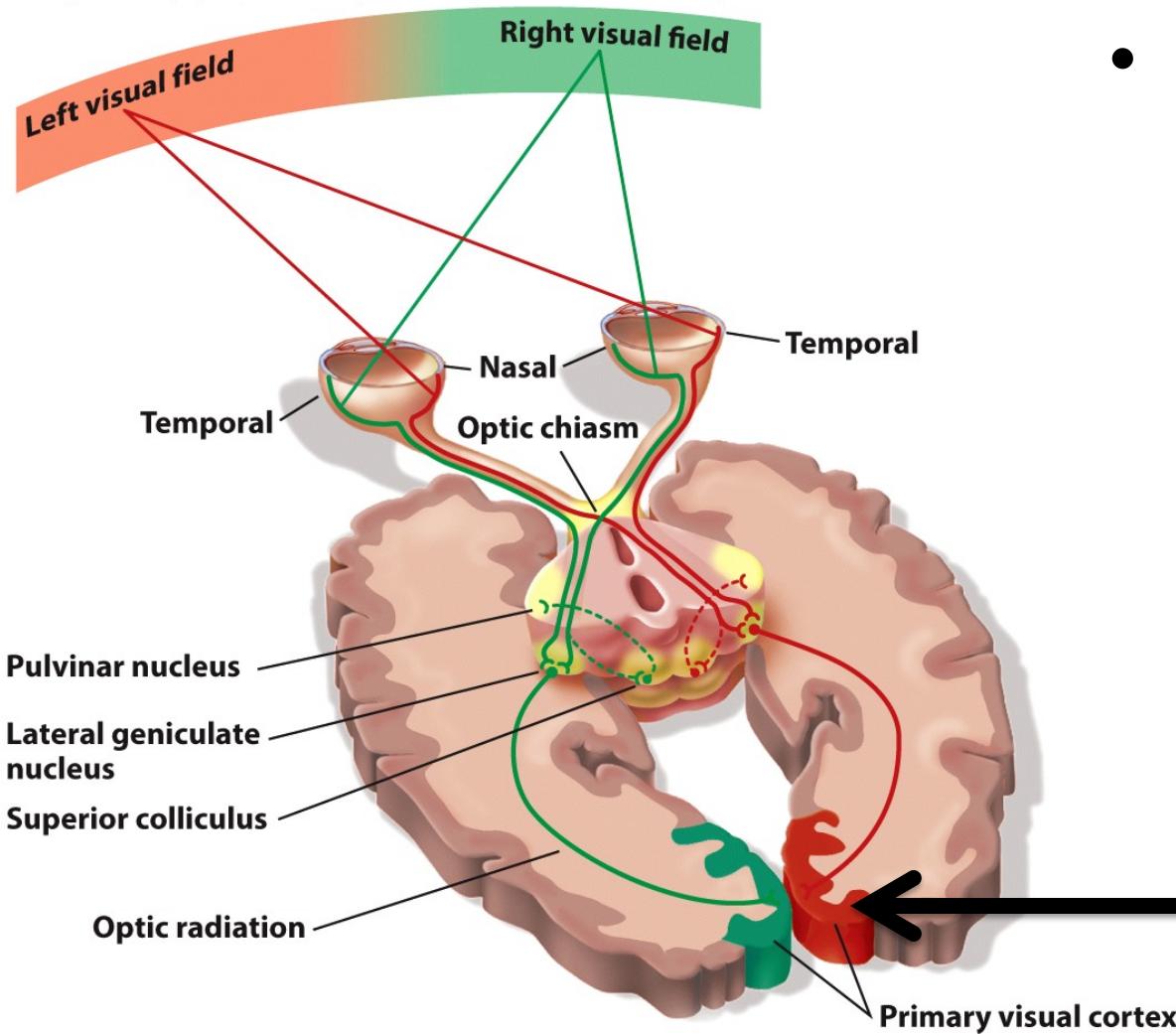
2



3



# Flow of information from optic nerve to V1



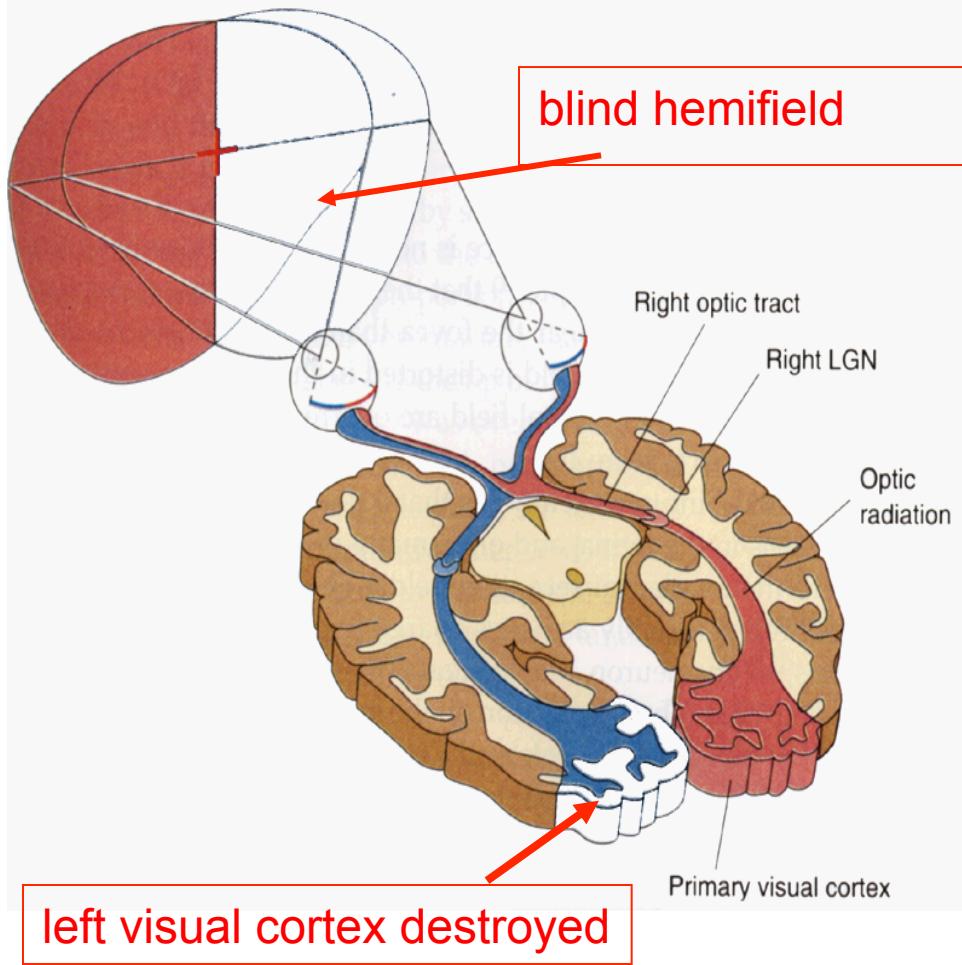
- Cortical blindness
- But residual vision through subcortical pathway
  - Motor responses to “invisible”

Lesion here?

# Blindsight: some perception in “blind” parts of visual field



# Blindsight: some perception in “blind” parts of visual field



Patient fixates cross and test for function in the blind hemi-field (make them guess)

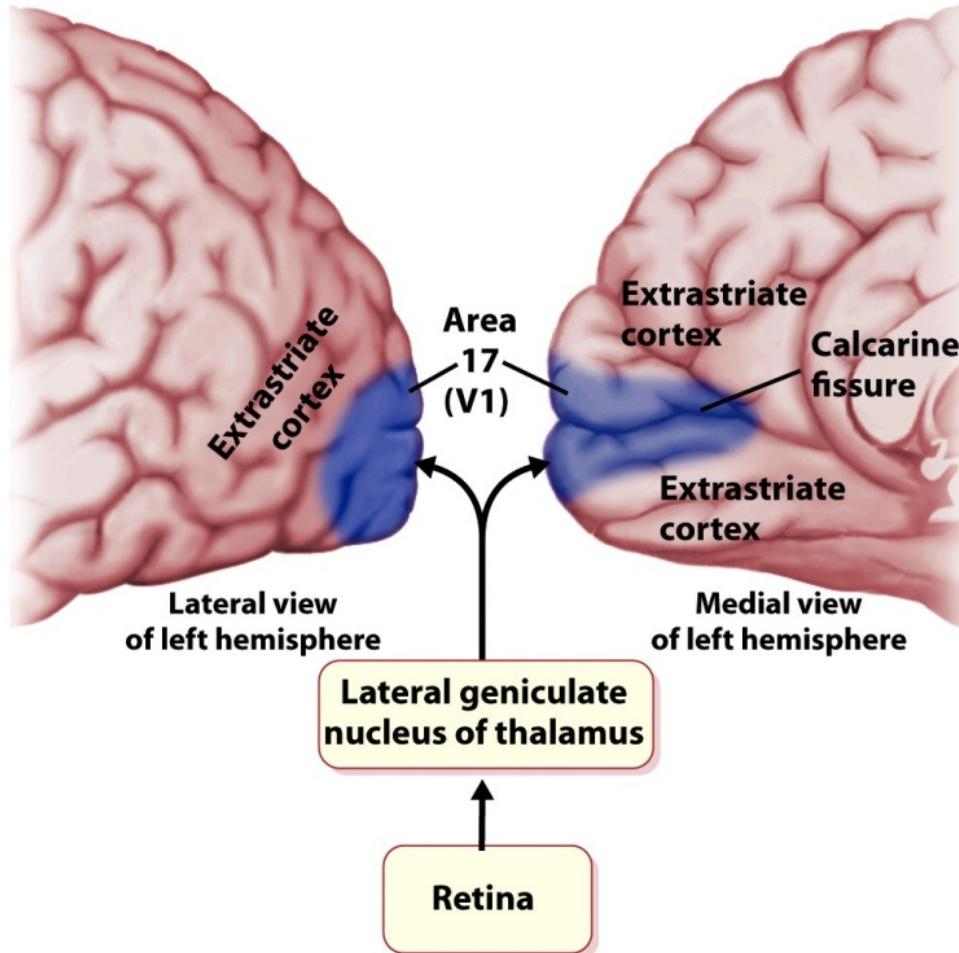
In the blind field, patients can identify stimulus properties

- direction of motion
- size
- line orientation
- simple shapes

How does this happen?

- Subcortical pathways
- residual V1 function

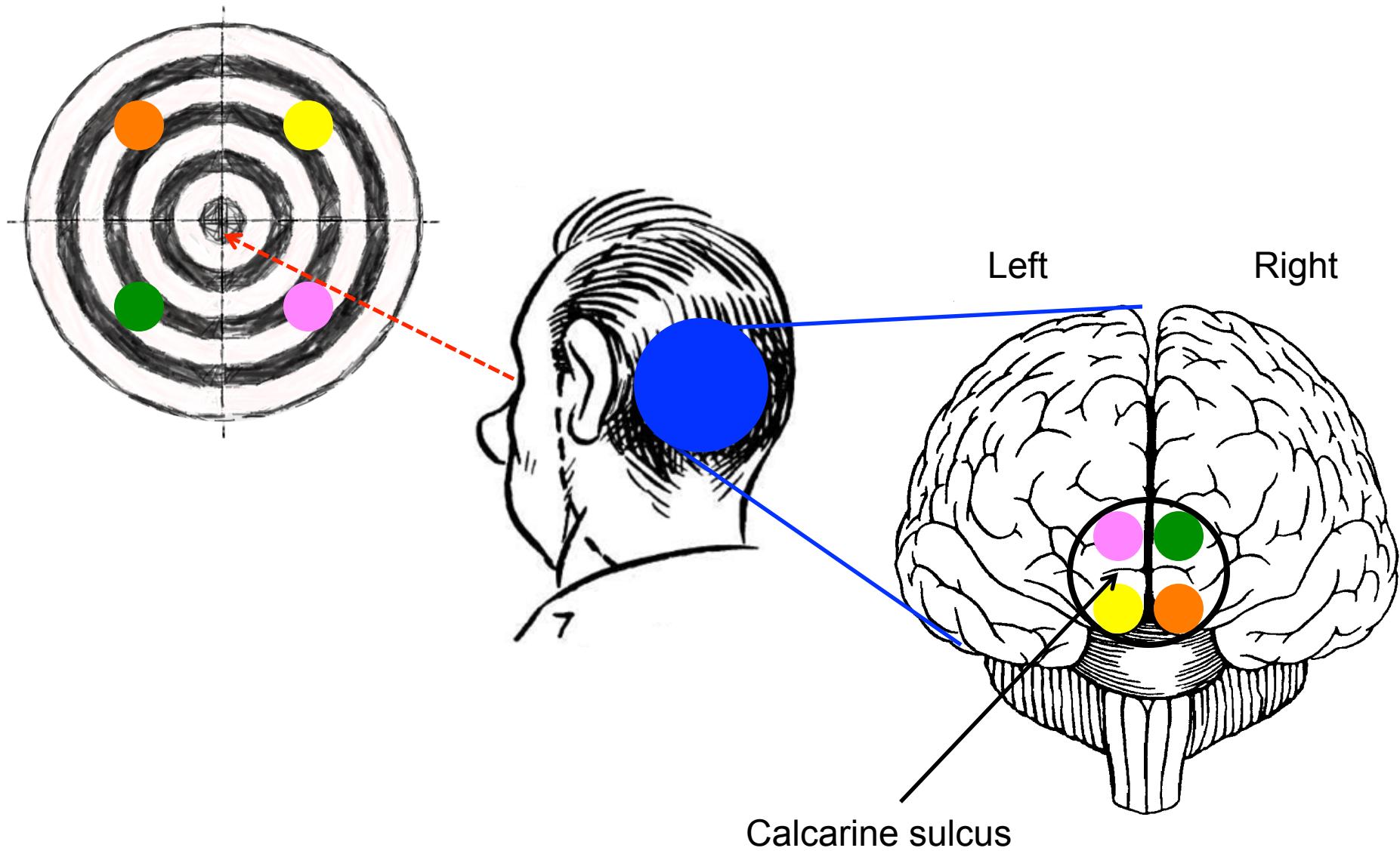
# Primary Visual Cortex, V1



- Upper visual field = inferior to calcarine
- Lower visual field = superior to calcarine

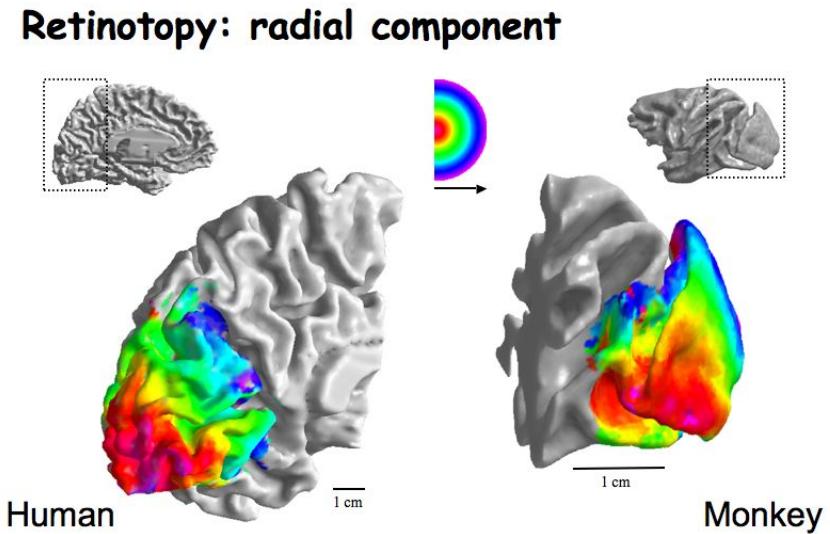
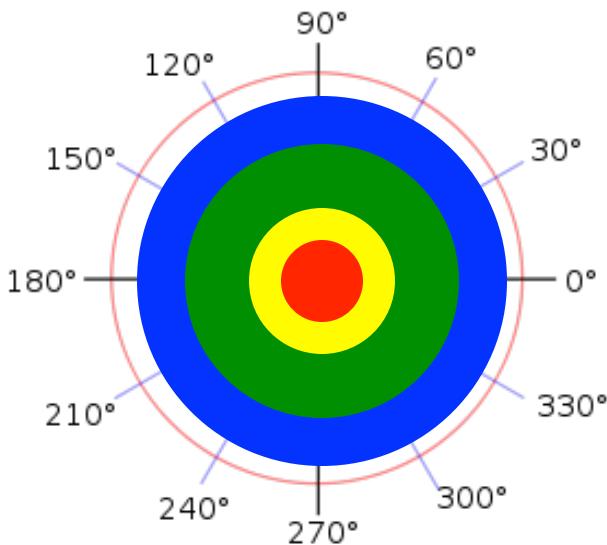
Calcarine sulcus divides upper + lower hemifields.

# Visual field and visual cortex



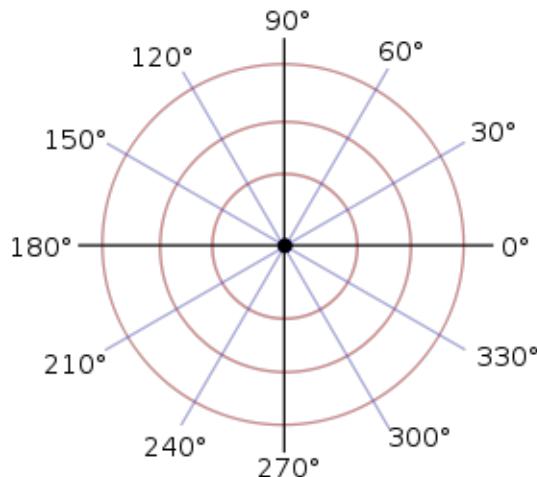
# Organization of visual cortex

- topography of the visual world is preserved in V1~v4

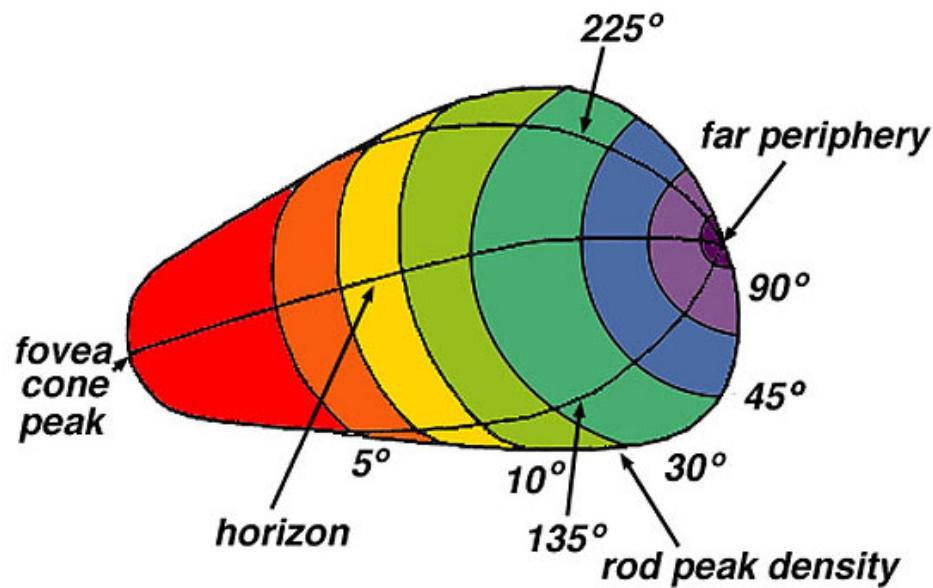
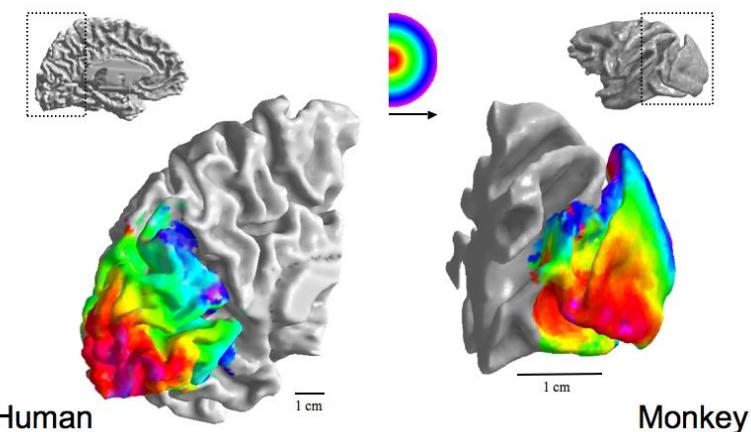


# Transform Cartesian to Polar Coordinates

- Fovea is most posterior representation in V1 (back of head)
- Peripheral is more anterior.



Retinotopy: radial component



- What could you do with knowledge of how visual information is mapped onto visual cortex?

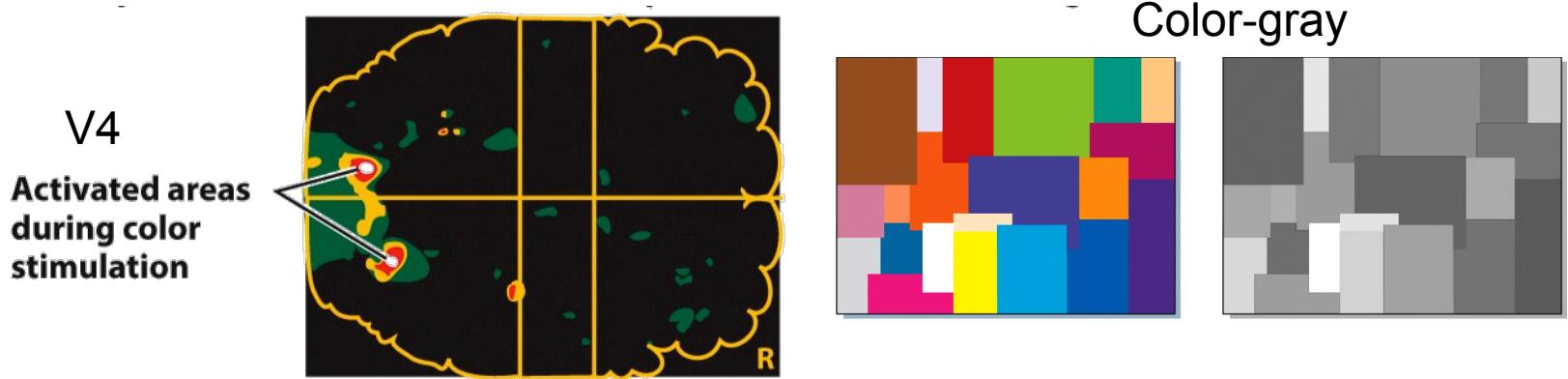
Presented clip



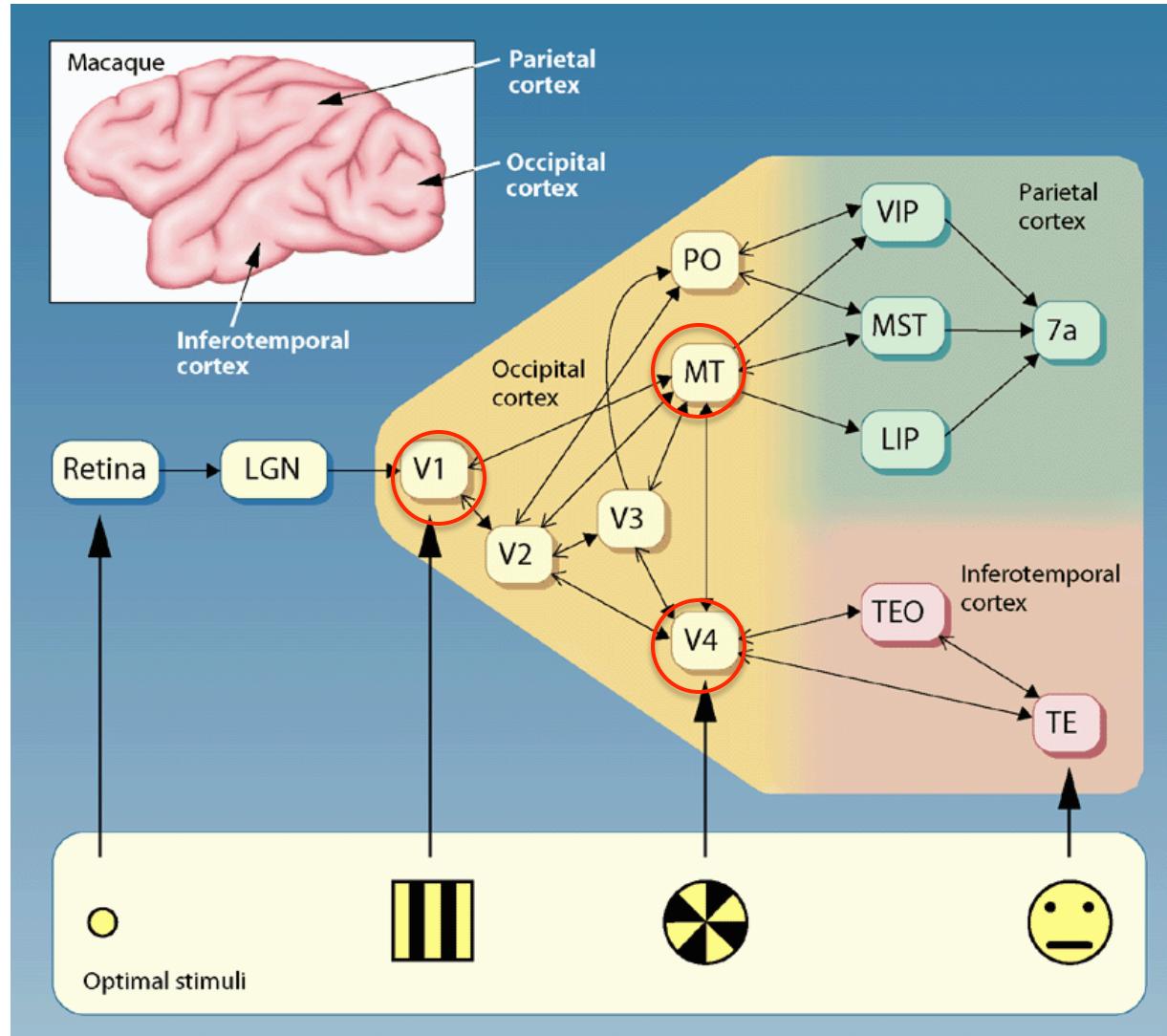
Clip reconstructed  
from brain activity



# Specialized feature processing in the human brain



# Next stop: V4, MT

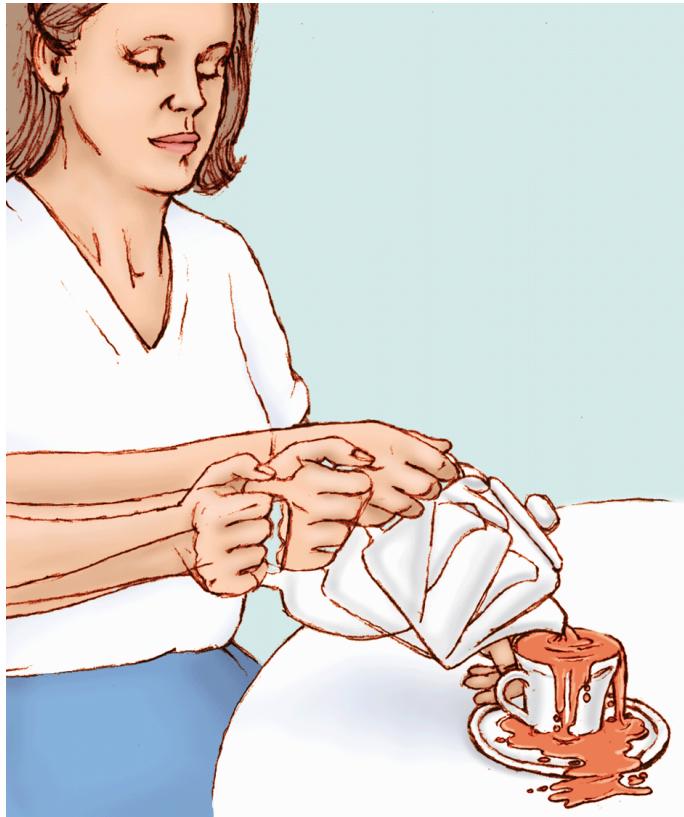


Dorsal pathway

Ventral pathway

Van Essen and DeYoe 1995

# What does someone with MT damage see?



Lesions to V5/MT can produce akinetopsia, a deficit in motion perception

What does someone with V4 damage see?

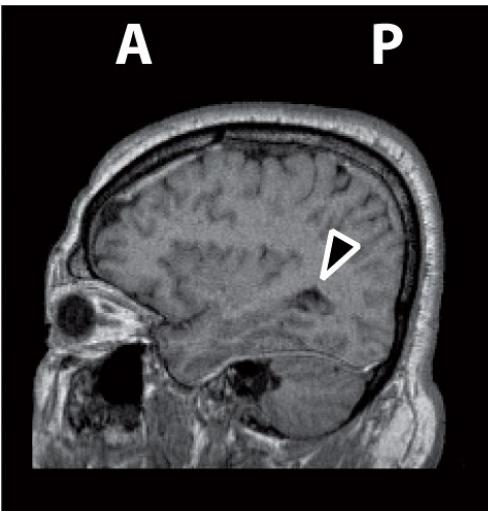
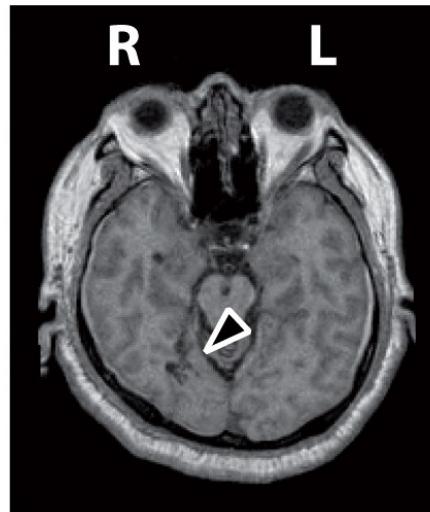
Lesions in V4 can lead to achromatopsia (color agnosia), a deficit in color perception

how the world might  
look to a person with  
achromatopsia

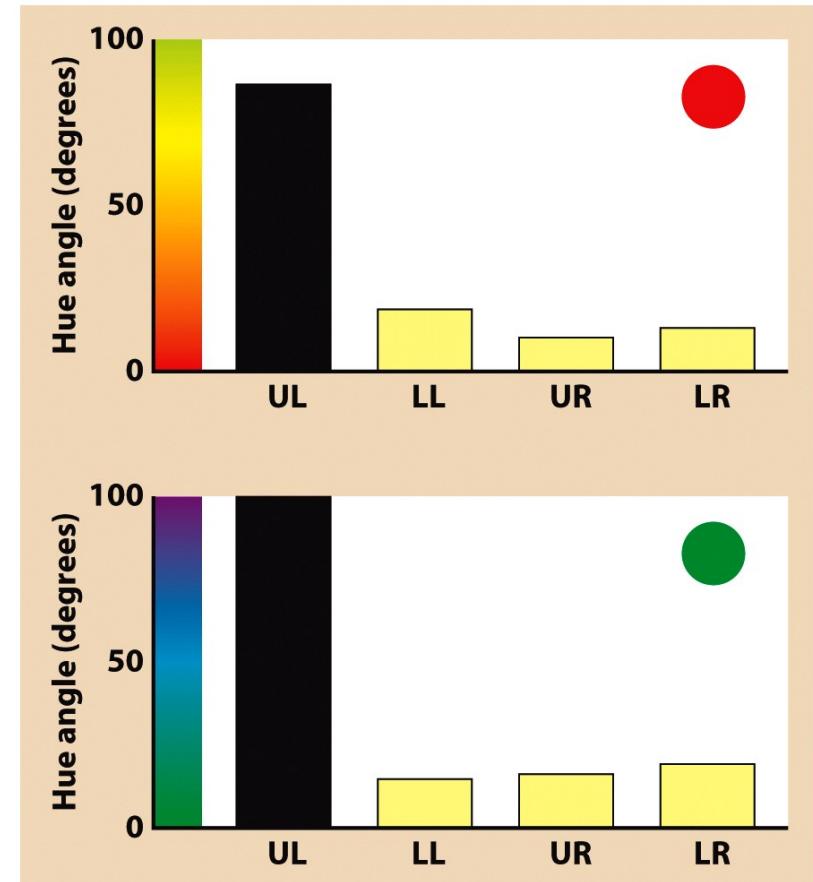


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# Color perception with a unilateral lesion of V4

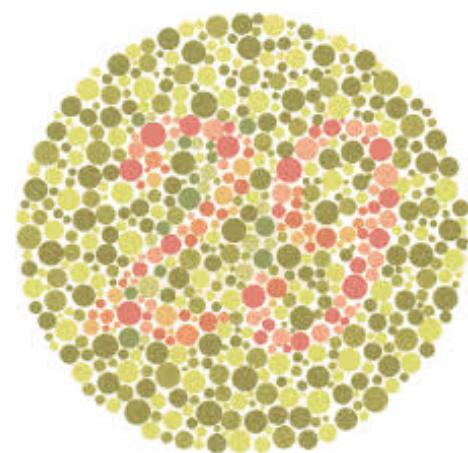


UL = upper left  
LL = lower left  
UR = upper right  
LR = lower right



# Achromatopsia vs. Color Blindness

- V4 lesion leads to cerebral achromatopsia (color agnosia).
  - Loses all color vision regardless color hues
- Color blindness is caused by problems with cones in retina
  - Often red-green color blindness when one cone is deficient



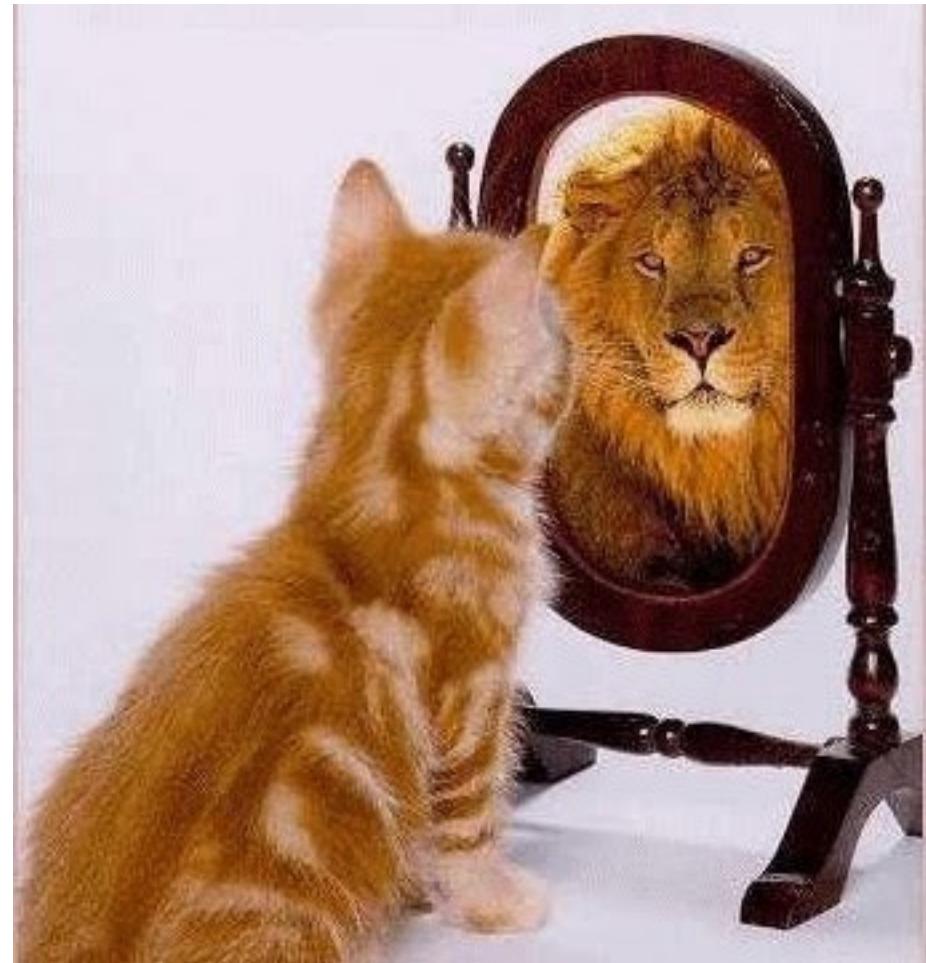
# Double dissociation

	MT Lesion	V4 Lesion
Motion perception	X	✓
Color perception	✓	X



# Perception is not a faithful/veridical replication of the environment

- Functional overrepresentation in cortical organization
  - Sensory maps
  - Cortical magnification
- Cortical plasticity
- Illusory perceptual filling-in: perceptual reconstruction
- Metaphor representation



# Perception is not a faithful replication of stimuli in the environment

- Perceptions are constructions by our CNS and reflect the behavioral function of sensory information.

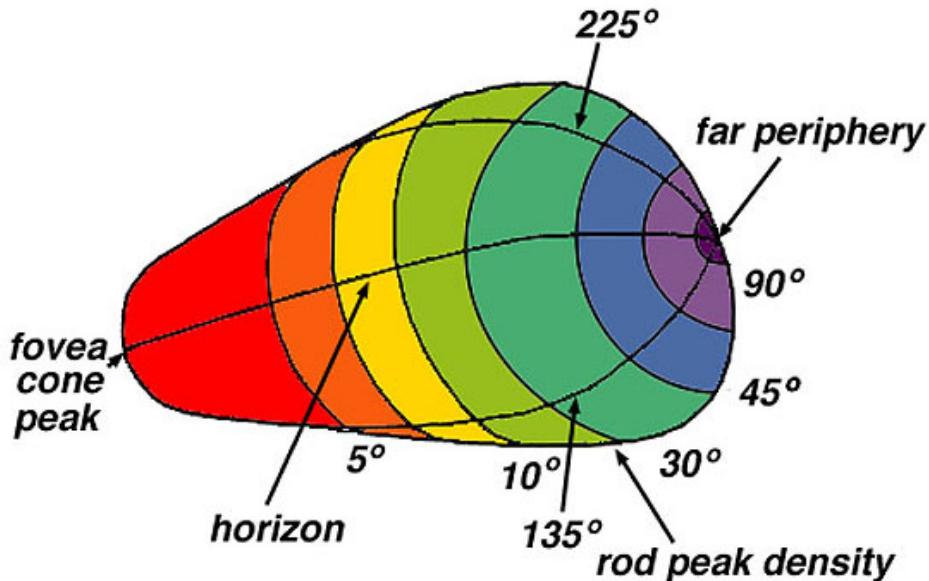
Visual system: over-representation of central vision.



Somatosensory system: over-representation of thumb, mouth, tongue .



# Visual cortex – magnification at fovea

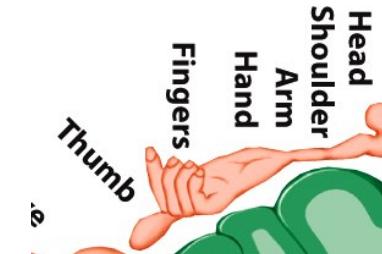
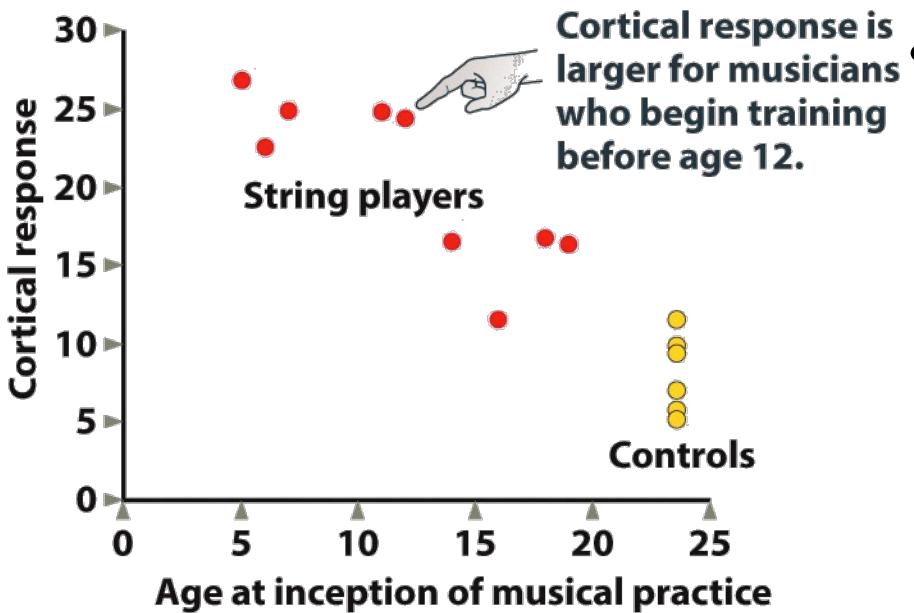
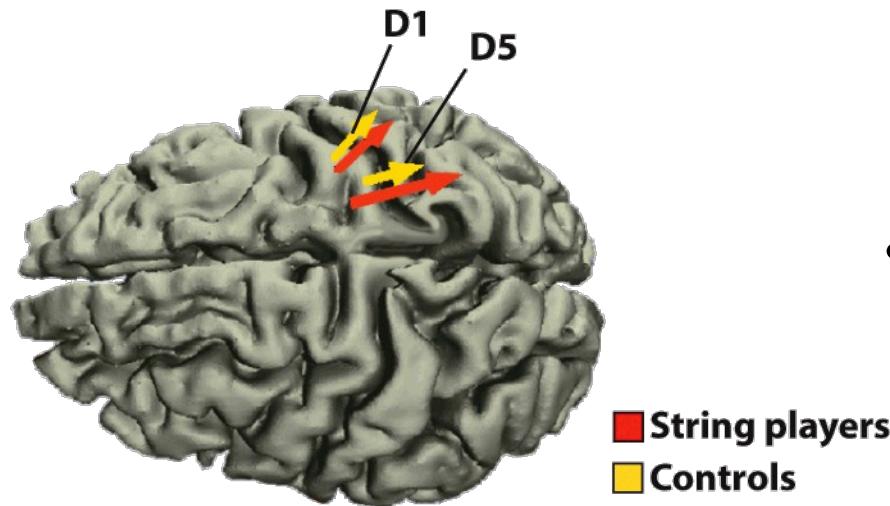


- Large cortex involved in processing foveal information
  - Less cortex as you move more peripheral

# Foveal magnification



## Increase in cortical representation of the fingers in musicians who play string instruments



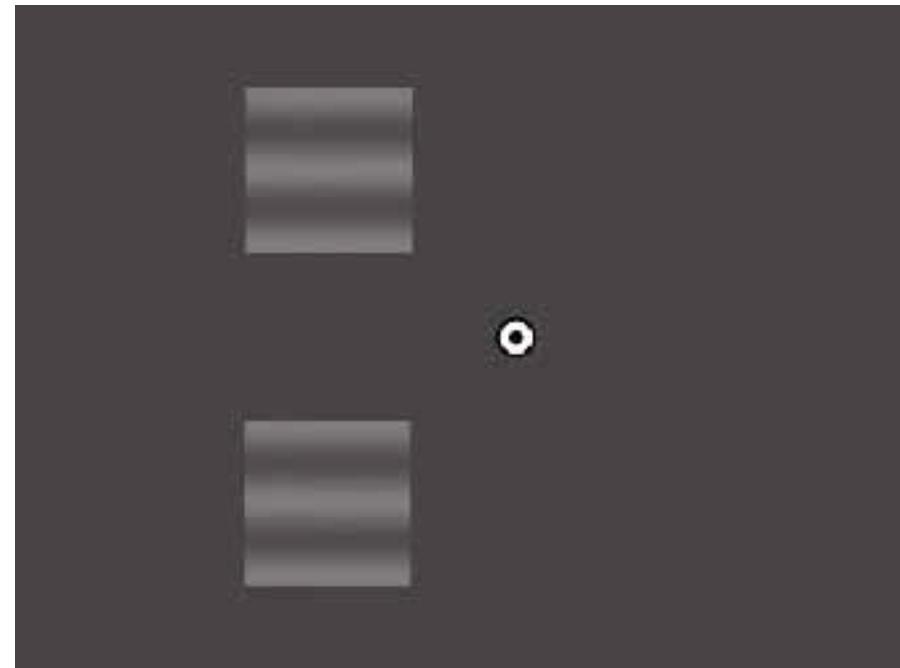
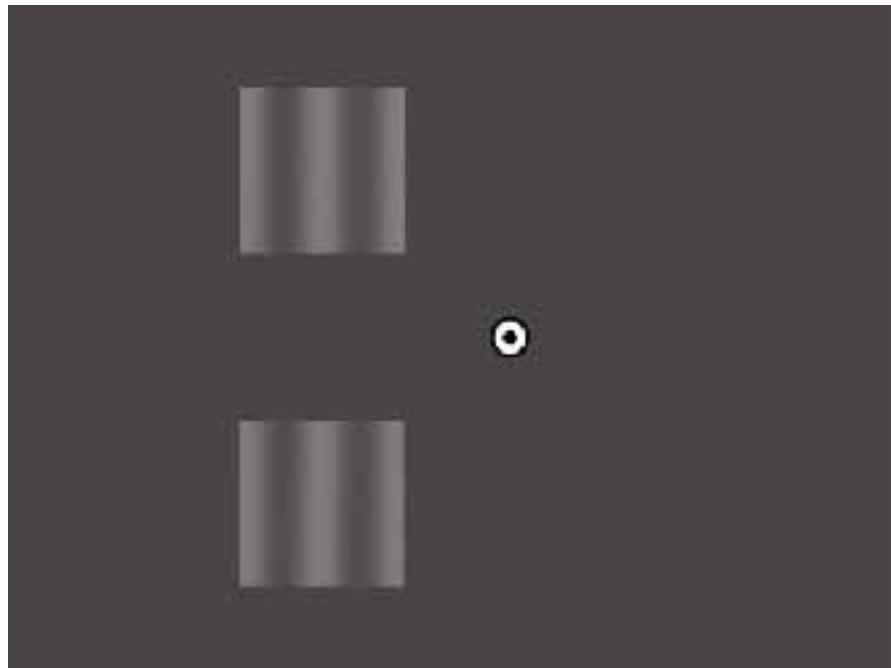
- Larger responses in somatosensory cortex following stimulation of thumb (D1) and pinkie (D5) for musicians than controls
- For musicians, the earlier musical training started, the larger responses

# Cortical Magnification: sematosensory

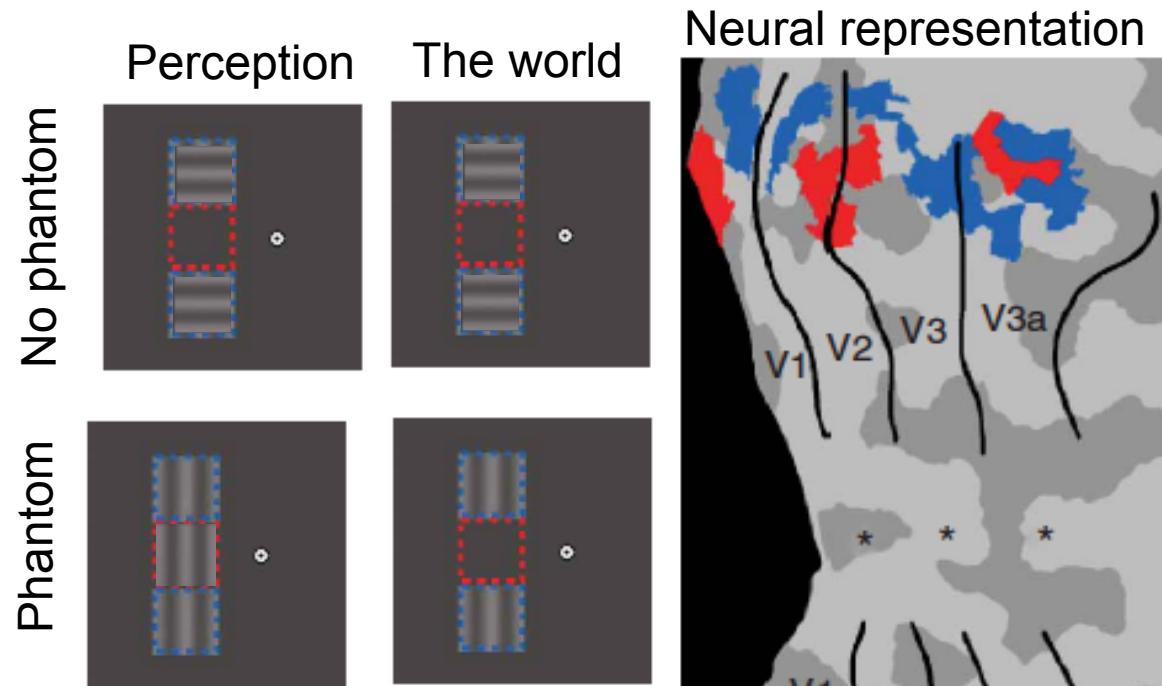
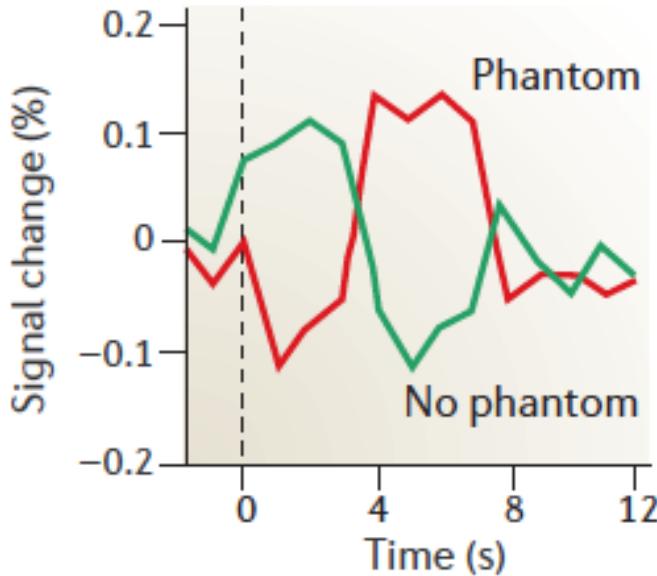


- Enhanced thumb sensory representation for smartphone users
- Can be induced with just 10 days of touch screen use

# Perceptual Filling-in: Reconstructive



# Perceptual Filling-in: Reconstructive



- The activity in the gap region (red square) increased after the phantom was perceived, and decreased when the phantom disappeared
- Providing the neural mechanisms of perceptual filling-in

# Effects of Cog-social Factors on Luminance Perception

- Positive emotion makes things to look lighter (Meier et al., 2007)
- Recalling moral behavior increases perceived brightness (Banerjee et al., 2012)
- Smiles brighten up perceived facial lightness (Song et al., 2013)



# Two possibilities

1. Metaphor representation perspective
  - Light and darkness have always been symbols of good and evil
  - *Biases us to think they're lighter or darker*
2. Cognitive neuroscience perspective
  - ‘Lighter’ metaphors change our *sensation*

# Cog-social Factors & Perception

Metaphor representation perspective  
“bright smile”:

**CogNeural mechanism**

The diagram illustrates the cognitive-social factors and perception mechanism. It features a cat's face at the top, followed by a brain cross-section showing the visual pathways from the eyes through the optic chiasm, optic radiations, lateral geniculate nuclei, and pulvinar nuclei to the superior colliculus and primary visual cortex. Labels include: Left visual field, Right visual field, Nasal, Temporal, Optic chiasm, Pulvinar nucleus, Lateral geniculate nucleus, Superior colliculus, Optic radiation, and Primary visual cortex. A blue arrow points from the text “bright smile” towards the brain diagram. Below the brain, a red oval encloses the text “CogNeural mechanism”. To the right, a graph titled “Perceived Brightness” shows a horizontal axis labeled “Pupil size” with two squares: a dark gray square under “Negative condition (Smaller Pupil Size) Darker Perception” and a light gray square under “Positive emotion (Larger Pupil Size) Lighter Perception”.

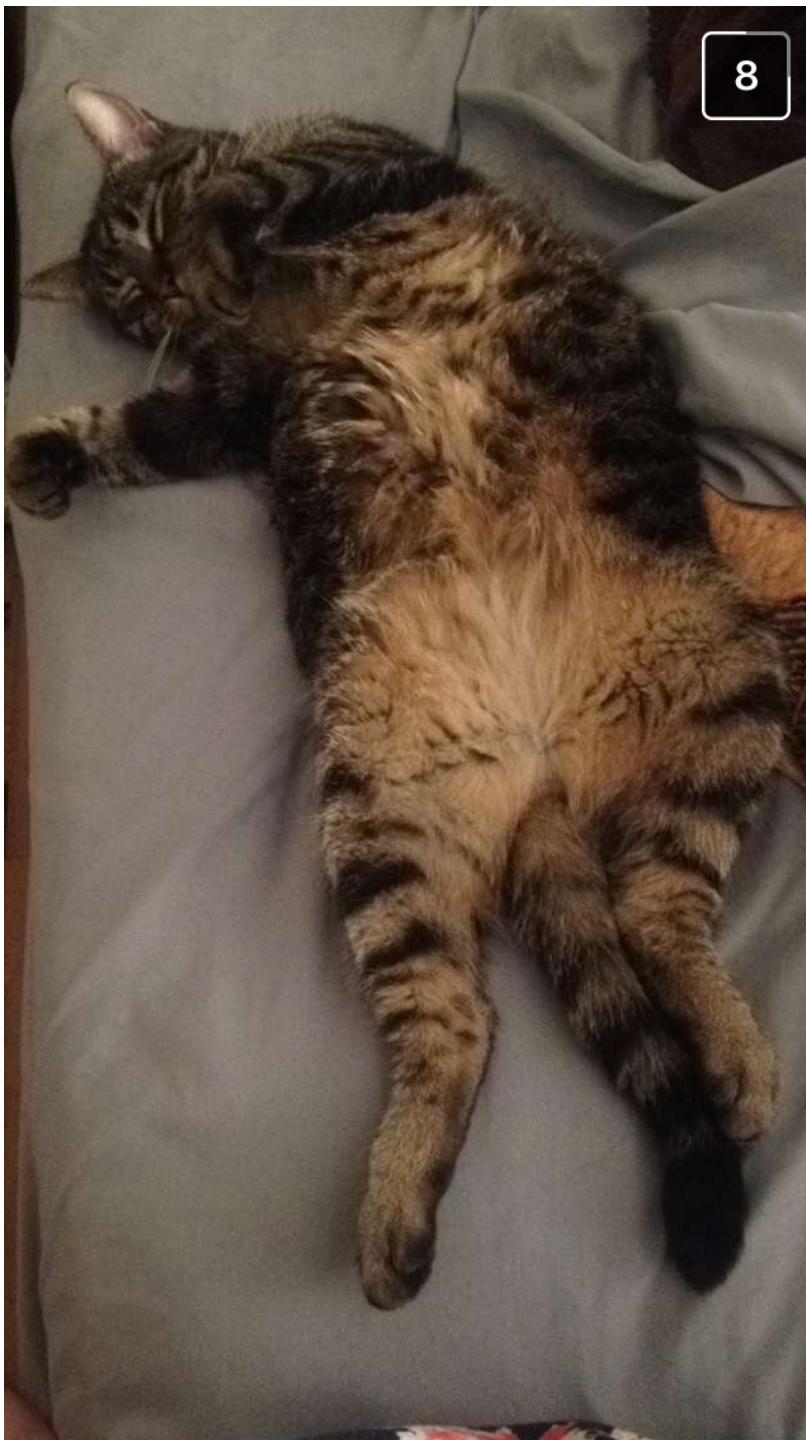
Perceived Brightness

Pupil size

Negative condition  
(Smaller Pupil Size)  
Darker Perception

Positive emotion  
(Larger Pupil Size)  
Lighter Perception

1. Emotion activates Locus Coeruleus LC, and then modulating pupil size Via LC-Norepinephrine system (LC-NE)
2. Consequently, change perceived brightness



# Essentials: Vision

- Vision
  - Visual hierarchy & pathway
  - what happens with damages to different parts of visual pathway.
- Vision ≠ Camcorder: Flexible mapping between external world and perception
  - Functional overrepresentation
  - Cortical plasticity
  - Perceptual filling-in
  - Cog-social factors